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# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 02R00495/PC	<b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/JP 03/15200	International filing date (day/month/year) 27.11.2003	Priority date (day/month/year) 30.11.2002
International Patent Classification (IPC) or both national classification and IPC H01L21/203		
Applicant SHARP KABUSHIKI KAISHA et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 6 sheets, including this cover sheet.  
  
☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).  
  
 These annexes consist of a total of 1 sheets.

3. This report contains indications relating to the following items:
  - I ☒ Basis of the opinion
  - II ☐ Priority
  - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
  - IV ☐ Lack of unity of invention
  - V ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
  - VI ☐ Certain documents cited
  - VII ☐ Certain defects in the international application
  - VIII ☐ Certain observations on the international application

Date of submission of the demand  03.05.2004	Date of completion of this report  22.10.2004
Name and mailing address of the international preliminary examining authority:   European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized Officer  Mauger, J  Telephone No. +49 89 2399-8447  

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT**

International application No. **PCT/JP 03/15200**

**I. Basis of the report**

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

**Description, Pages**

1-16 as originally filed

**Claims, Numbers**

10-23 as originally filed

1-6, 8, 9 filed with telefax on 04.10.2004

**Drawings, Sheets**

1/3-3/3 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).  
☐ the language of publication of the international application (under Rule 48.3(b)).  
☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.  
☐ filed together with the international application in computer readable form.  
☐ furnished subsequently to this Authority in written form.  
☐ furnished subsequently to this Authority in computer readable form.  
☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.  
☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:  
☒ the claims, Nos.: 7  
☐ the drawings, sheets:

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5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

*(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)*

6. Additional observations, if necessary:

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Yes: Claims	3-6, 8-20
	No: Claims	1,2,21-23
Inventive step (IS)	Yes: Claims	8-12
	No: Claims	1-6,13-23
Industrial applicability (IA)	Yes: Claims	1-6,8-23
	No: Claims	

2. Citations and explanations

**see separate sheet**

**Re Item V**

**Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1) Reference is made to the following documents:

- D1: MAYER M ET AL: "Reactive MBE of group III nitrides: high-quality homoepitaxial GaN and ultra-violet light-emitting diodes" JOURNAL OF CRYSTAL GROWTH, NORTH-HOLLAND PUBLISHING CO. AMSTERDAM, NL, vol. 201-202, May 1999 (1999-05), pages 318-322, XP004175132 ISSN: 0022-0248
- D2: MAYER M ET AL: "Device performance of ultra-violet emitting diodes grown by MBE" JOURNAL OF CRYSTAL GROWTH, NORTH-HOLLAND PUBLISHING, AMSTERDAM, NL, vol. 189-190, 15 June 1998 (1998-06-15), pages 782-785, XP004148622 ISSN: 0022-0248
- D3: ABERNATHY C R ET AL: "Growth of group III nitrides by metalorganic molecular beam epitaxy" JOURNAL OF CRYSTAL GROWTH, NORTH-HOLLAND PUBLISHING CO. AMSTERDAM, NL, vol. 178, no. 1-2, 1 June 1997 (1997-06-01), pages 74-86, XP004084976 ISSN: 0022-0248
- D4: YANG Z ET AL: "HIGH-QUALITY GAN AND AIN GROWN BY GAS-SOURCE MOLECULAR BEAM EPITAXY USING AMMONIA AS THE NITROGEN SOURCE" JOURNAL OF VACUUM SCIENCE AND TECHNOLOGY: PART B, AMERICAN INSTITUTE OF PHYSICS. NEW YORK, US, vol. 14, no. 3, 1 May 1996 (1996-05-01), pages 2354-2356, XP000621863 ISSN: 0734-211X

2) Document D3 (see section "4. Doping") discusses the doping of Group III nitrides. The document refers in particular to GaN and states that "for p-type material, the most common gaseous precursor for introduction of Mg during growth by MOCVD or MOMBE is  $\text{Cp}_2\text{Mg}$ ". This part of document D3 evidently refers mainly to MOCVD processes and suggests that the use of  $\text{Cp}_2\text{Mg}$  is associated with problems. Nevertheless the sentence cited unambiguously states that  $\text{Cp}_2\text{Mg}$  is a source of Mg dopants in MOMBE growth. This disclosure is sufficient to be novelty destroying for claims 1,2 and 21-23 (Article 33(2) PCT).

2.1) Document D4 (see whole document) discloses MBE grown Mg-doped p-type GaN grown using elemental Mg as the dopant source. The present application states that the present doping process is easier to control than one using elemental Mg

but contains no indication that Mg-doped p-type GaN grown using the present process is distinguishable from that grown using the method of document D4. Thus the subject-matter of claims 21-23 lacks novelty as compared to the disclosure of document D4.

- 2.2) The two related documents D1 (see 2. Experimental procedure, 4. Ultra-violet light emitting diodes) and D2 (see the whole document) disclose the MBE growth of p-type group-III nitrides using metallic gallium and aluminium sources, ammonia and methylCp<sub>2</sub>Mg as the magnesium source. The growth temperature was only mentioned in D1 and was about 750°C. No post growth anneal was needed and a hole concentration of about 10<sup>17</sup> cm<sup>-3</sup> was obtained. The application shows that under particular growth conditions (temperature and dopant beam pressure) devices and layers can be obtained which are superior to those disclosed in D1 and D2. The products of claims 21-23 are not limited to ones obtained under these conditions. The claims encompass products made under conditions which will lead to products equivalent to those disclosed in documents D1 and D2 and thus documents D1 and D2 are novelty destroying for the subject-matter of claims 21-23
- 3) The closest prior art for claims 1-20 is represented by documents D1 and D2. The subject-matter of all of these claims differs from the disclosure of documents D1 and D2 in that a different dopant source is used. Some of the claims also differ due to the growth temperature or beam pressure requirements.

The dopant source specified (Cp<sub>2</sub>Mg) although not previously used for MBE processes is clearly a well known alternative to the methylCp<sub>2</sub>Mg used in D1 and D2. The beam pressures specified are within known pressure ranges used in MBE and it is a standard procedure during MBE growth to determine appropriate beam pressures for individual components. Thus the subject-matter of claims 1-6 and 13-20 is not considered to involve an inventive step (Article 33(3) EPC).

- 3.1) The problem addressed by the use of the growth temperatures specified in claims 8-12 is the provision of doped layers with good crystalline quality in combination with a very low level of carbon contamination.

There is no teaching in the prior art suggesting conditions to a skilled person which will enable layers doped using Cp<sub>2</sub>Mg and having such desirable properties to be obtained. In particular the prior art provides no suggestion regarding process conditions which will allow carbon contamination to be minimised.

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Thus the subject-matter of claims 8-12 is not obvious and implies an inventive step (Article 33(3) PCT).